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Title: Improving Backlighter Design for Iron Opacity Measurements at the National Ignition Facility

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Improving Backlighter Design for Iron Opacity Measurements at the National Ignition Facility

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X Theoretical Design
Integrated Design & Assessment

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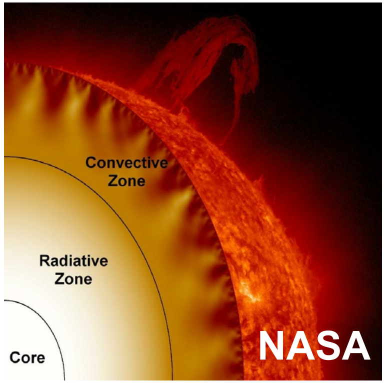
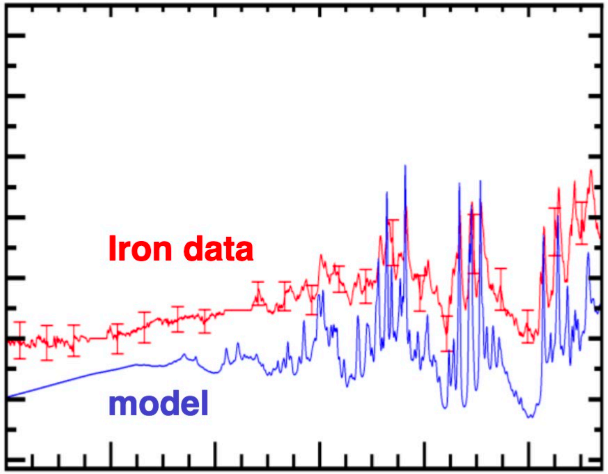
Model-predicted location of the sun's radiation-convection boundary disagrees with helioseismology observations

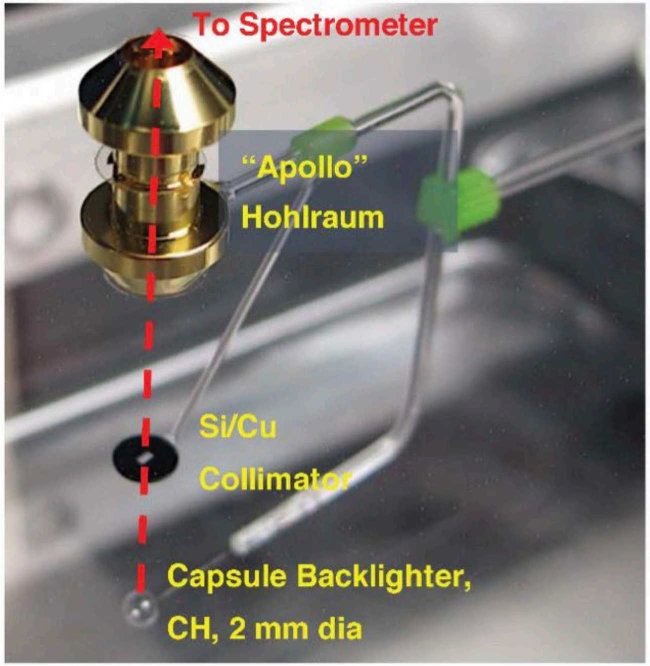
- **Arbitrary 10-20% opacity increase of the materials in this region would resolve this disagreement**
  - $T \approx 195$ eV; $n_e \approx 4 \times 10^{22}$ cm^{-3}
- **Z machine experiments show higher iron opacities at these conditions compared to the model opacities**
  - These results provide half the opacity adjustment needed to restore agreement





Perform iron opacity measurements at the NIF at solar interior conditions

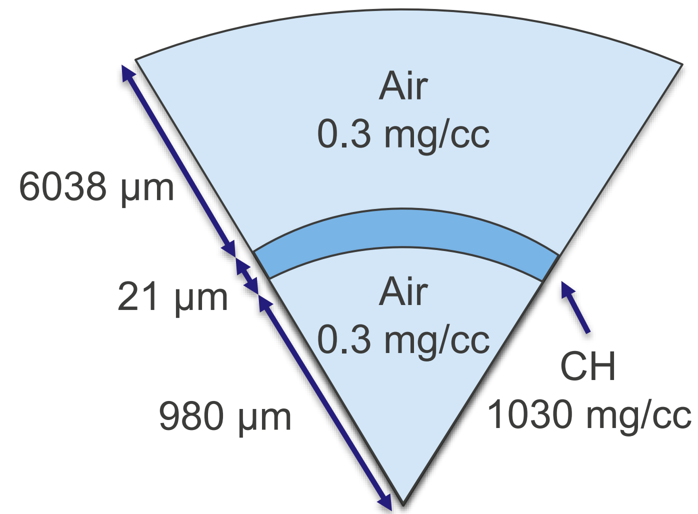
- **First measurements carried out in 2017 at less extreme conditions**
  - NIF and Z results at these conditions are in agreement
- **Moving towards experiments at higher *T* and n_e**
  - Stronger backlighter needed to overcome higher hohlraum and sample self-emission



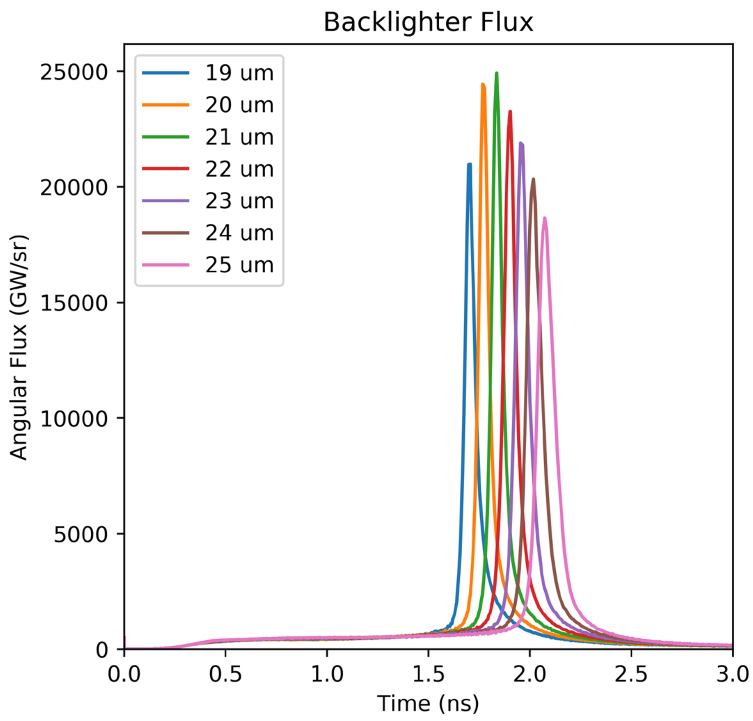
$T \approx 150$ eV; $n_e \approx 8.4 \times 10^{21}$ cm^{-3}

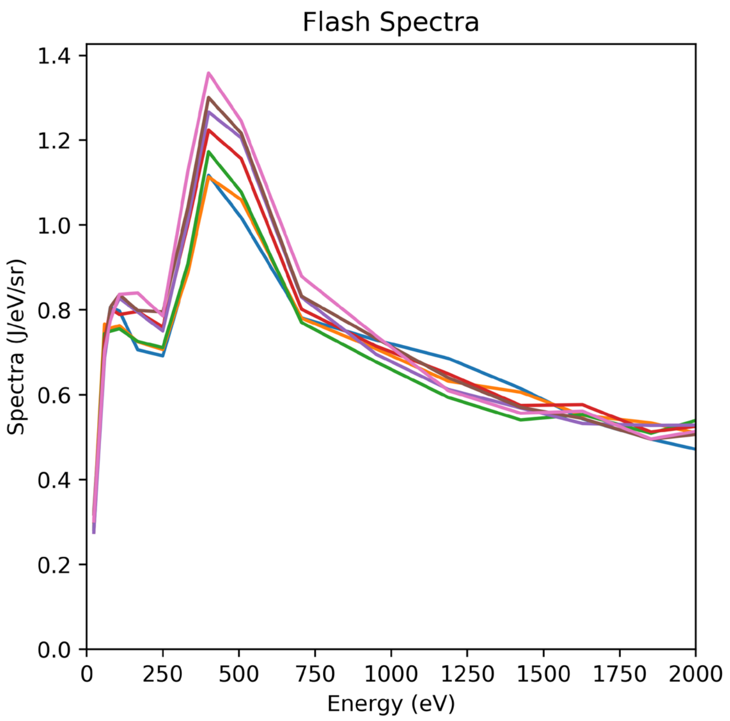
Investigate backlighter design using Cassio with implicit Monte Carlo radiation transport

- **Cassio is a multidimensional, multi-material, Eulerian, massively parallel radiation-hydrodynamics code**
- **3T, Multigroup IMC in 1DS using the laser package, SESAME EOS library, and opacity data gathered from the TOPS code**
- **Variations of the current backlighter design were simulated**
  - Capsule thickness
  - Linear density gradient
  - Triangular density gradient
- **Results extracted using a surface tally**
  - Tally calculates angular fluence in time bins
  - $\phi = \frac{\varphi_n - \varphi_{n-1}}{t_n - t_{n-1}}$ [GW/sr]

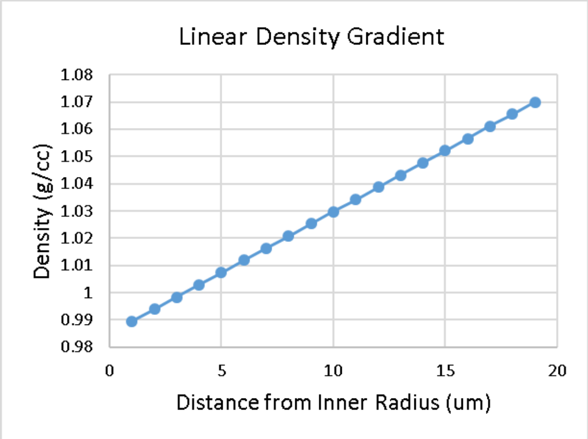


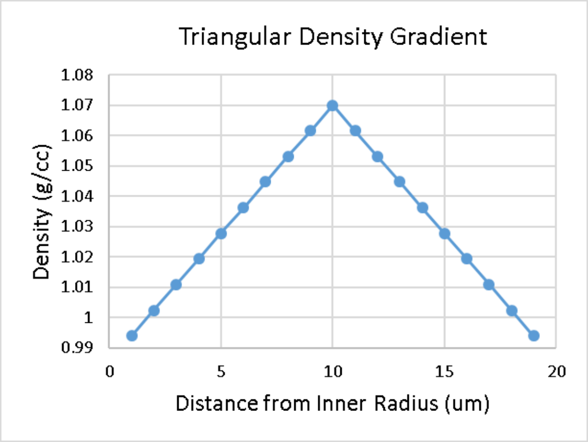
Increasing thickness from 19 µm to 21 µm leads to a 15 percent increase in the peak flux





Adding a density gradient has a minimal effect on backlighter performance





Case	Peak Angular Flux (GW/sr)
Constant Density	20,774
Linear Gradient	20,640
Triangular Gradient	21,182

Peak angular flux slightly increases with the slope of the linear density gradient

Linear Density Gradient Parameters		
ρ_{min}	ρ_{max}	Peak Angular Flux (GW/sr)
1.300	1.300	20,773
0.990	1.070	20,640
0.863	1.195	20,717
0.356	1.695	20,721

Conclusions & Future Work

- Increasing backlighter thickness from 19 um to 21 um raises the peak flux by 15%
- Adding a density gradient may not significantly change signal output from the backlighter
- 2D simulations are needed to model closer-to-design problems

Extra Slides

HYDRA results vs. measurements

Figure 2: Measured backlighter flux and pre-shot model; Measured spectra (DANTE and VIRGIL).